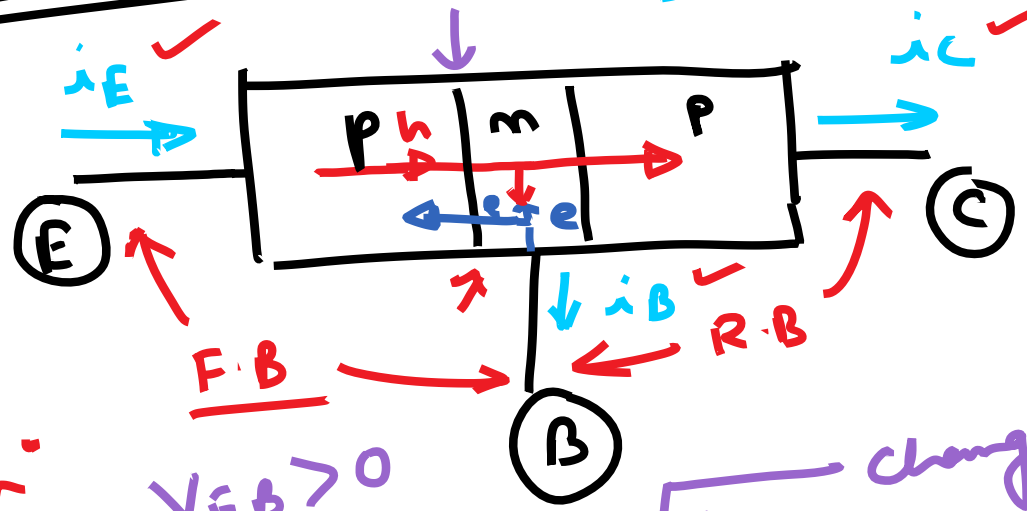
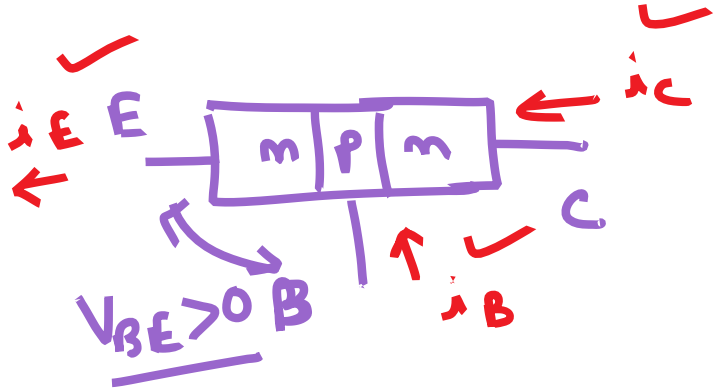
Bipolar Junction Transistor (BJT)

Last class
n-p-n BJT

P-n-P BJT



"Active region"



P-n-P BJT

$$i_E = I_{EO} \exp\left(\frac{V_{EB}}{V_T}\right)$$

change in com of

$$i_C \propto \exp\left(\frac{V_{EB}}{V_T}\right)$$

$$i_C = I_S \exp\left(\frac{V_{EB}}{V_T}\right)$$

Bipolar Junction Transistor (BJT)

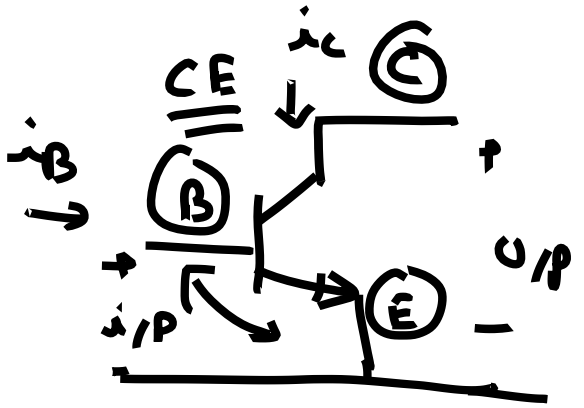
* Important Relations: (npn & pnp)

- $i_E = i_C + i_B \longrightarrow i_E = (1+\beta) i_B$
- $i_C = \beta i_B \longrightarrow$ Active region
- $i_C = \alpha i_E \longrightarrow i_C = \frac{\beta}{1+\beta} i_E$
- $\beta = \frac{\alpha}{1-\alpha}$
- $\alpha = \frac{\beta}{1+\beta}$

Bipolar Junction Transistor (BJT)

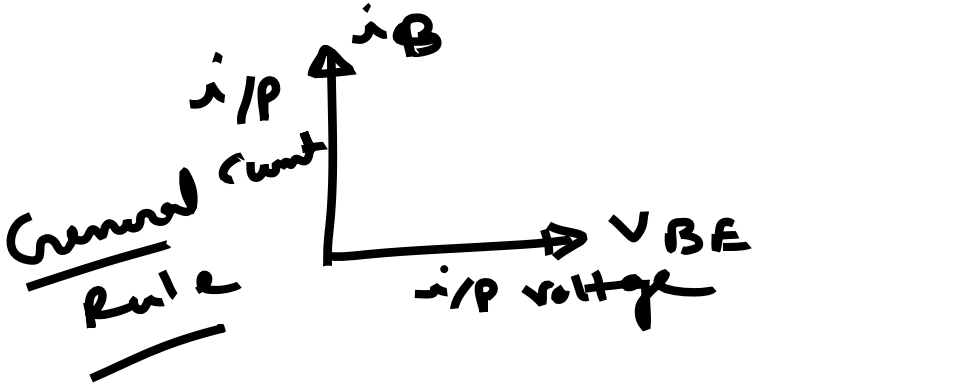
Configurations

(i) Common Emitter (CE) ✓
(ii) Common Base (CB) ✓
(iii) Common Collector (CC) ✓

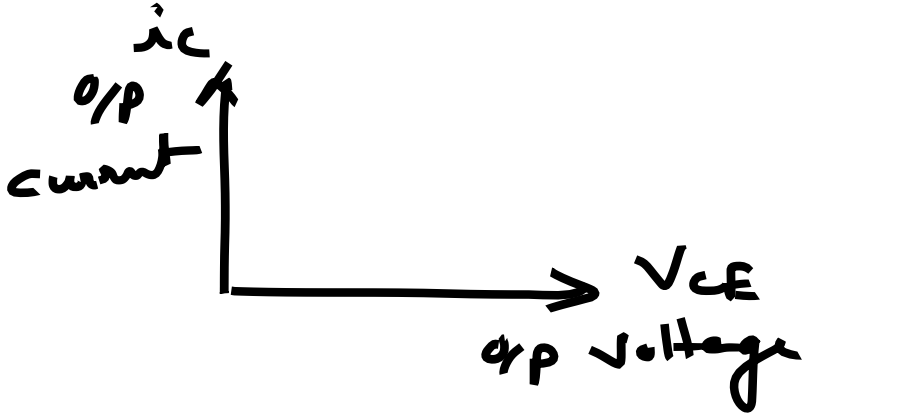


Characteristics:

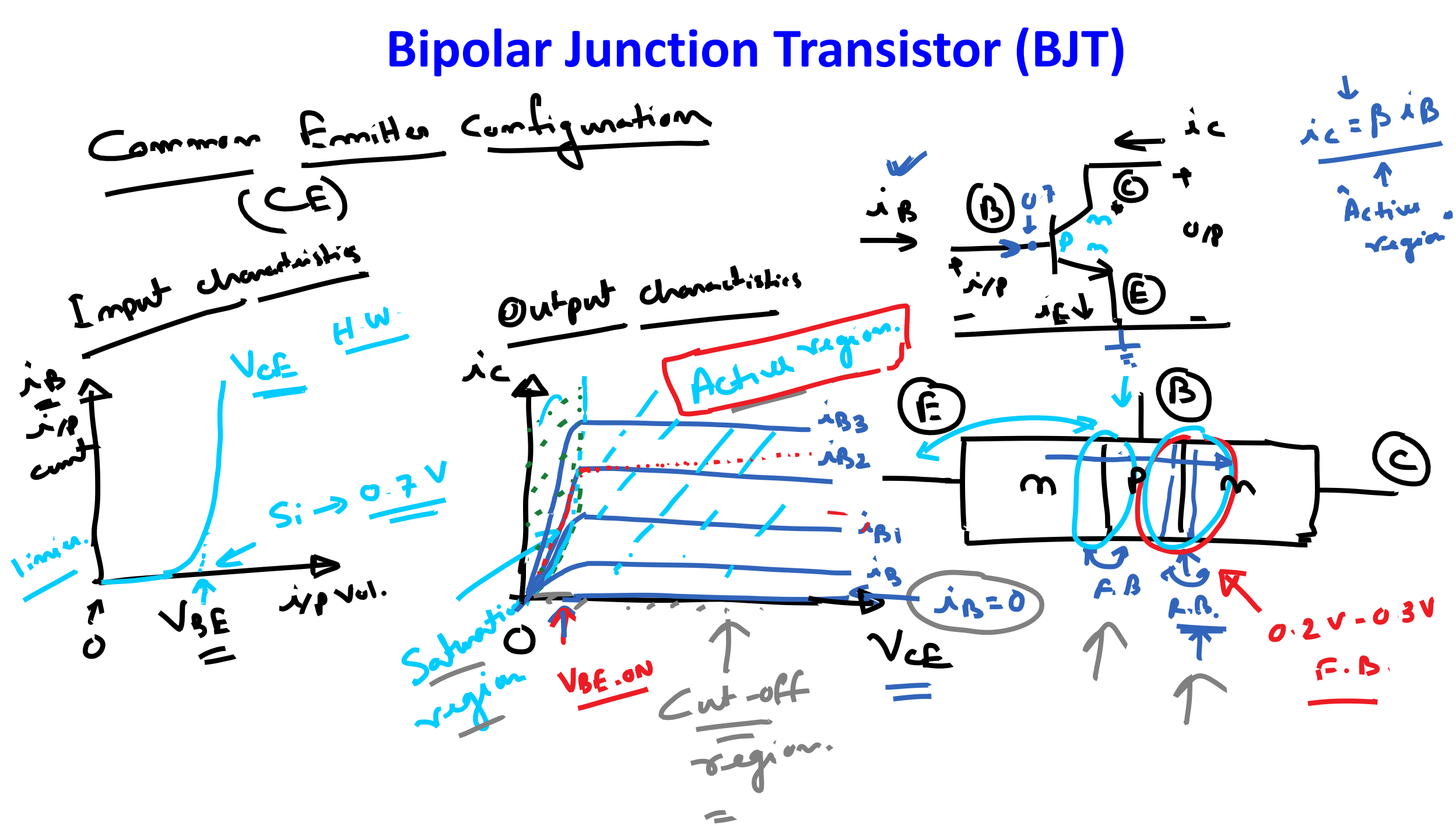
(i) Input Characteristics



(ii) o/p characteristics



Bipolar Junction Transistor (BJT)



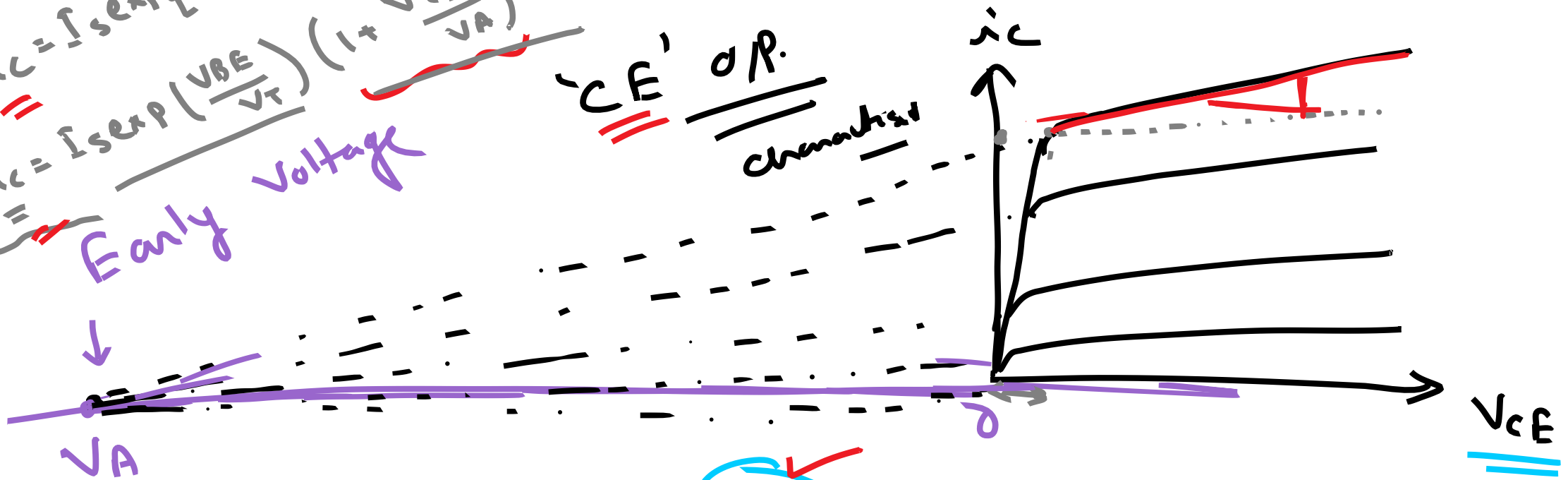
Bipolar Junction Transistor (BJT)

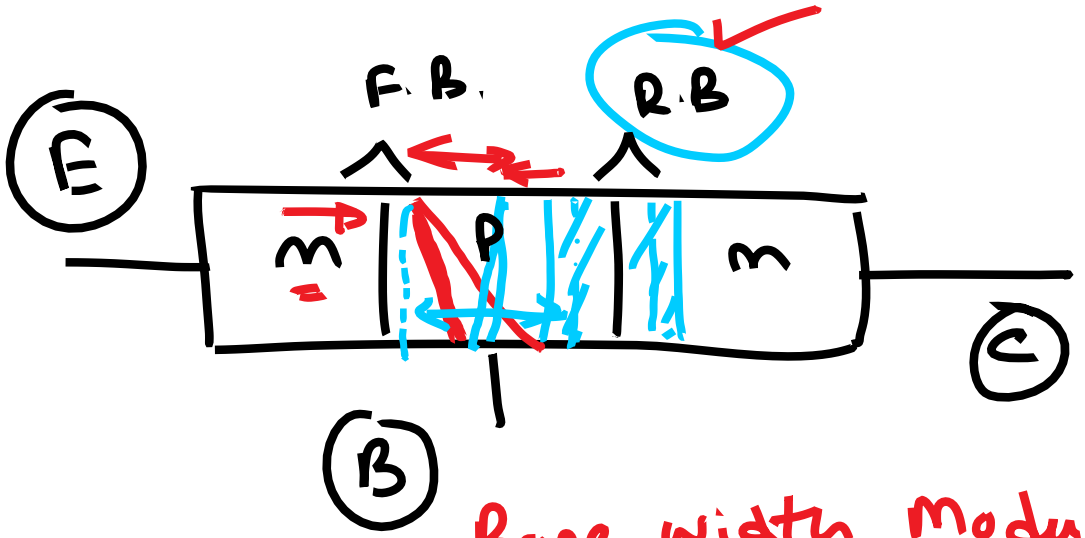
$i_C = I_S \exp\left[\frac{V_{BE}}{V_T}\right]$

$= I_S \exp\left(\frac{V_{BE}}{V_T}\right)\left(1 + \frac{V_{CE}}{V_A}\right)$

Early Voltage

'CE' o/p characteristics





$\alpha \frac{dn}{dn} \uparrow$

"Early Effect"

"J. M. Early"

Base width Modulation

Bipolar Junction Transistor (BJT)

$$i_C = I_S \exp\left(\frac{V_{BE}}{V_T}\right)\left[1 + \frac{V_{CE}}{V_A}\right]$$

Early voltage $r_o = \dfrac{\partial V_{CE}}{\partial i_C}$ → magnitude

$$\left.\frac{\partial i_C}{\partial V_{CE}}\right|_{V_{BE}} = \frac{1}{r_o} = I_S \exp\left(\frac{V_{BE}}{V_T}\right)\frac{1}{V_A} = \frac{I_C}{V_A}$$

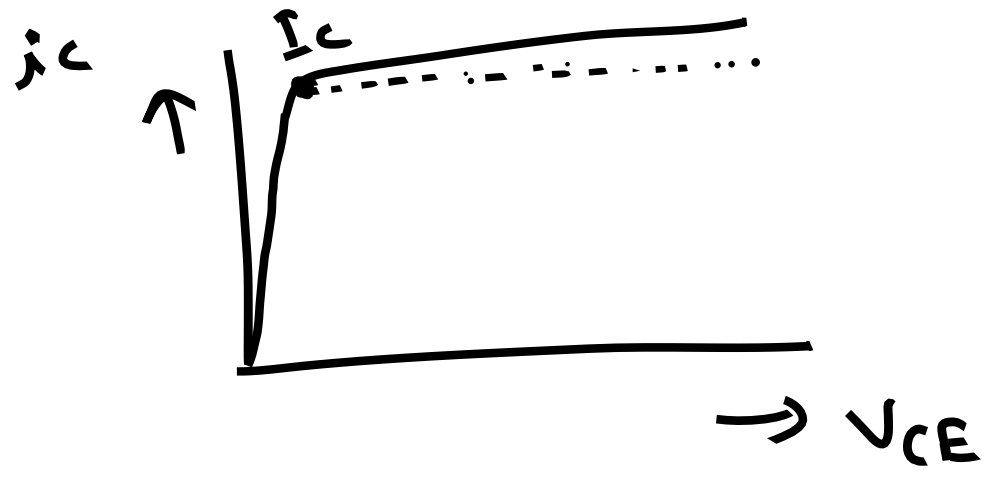
V_{BE} = constant

I_C

$$r_o = \frac{V_A}{I_C}$$

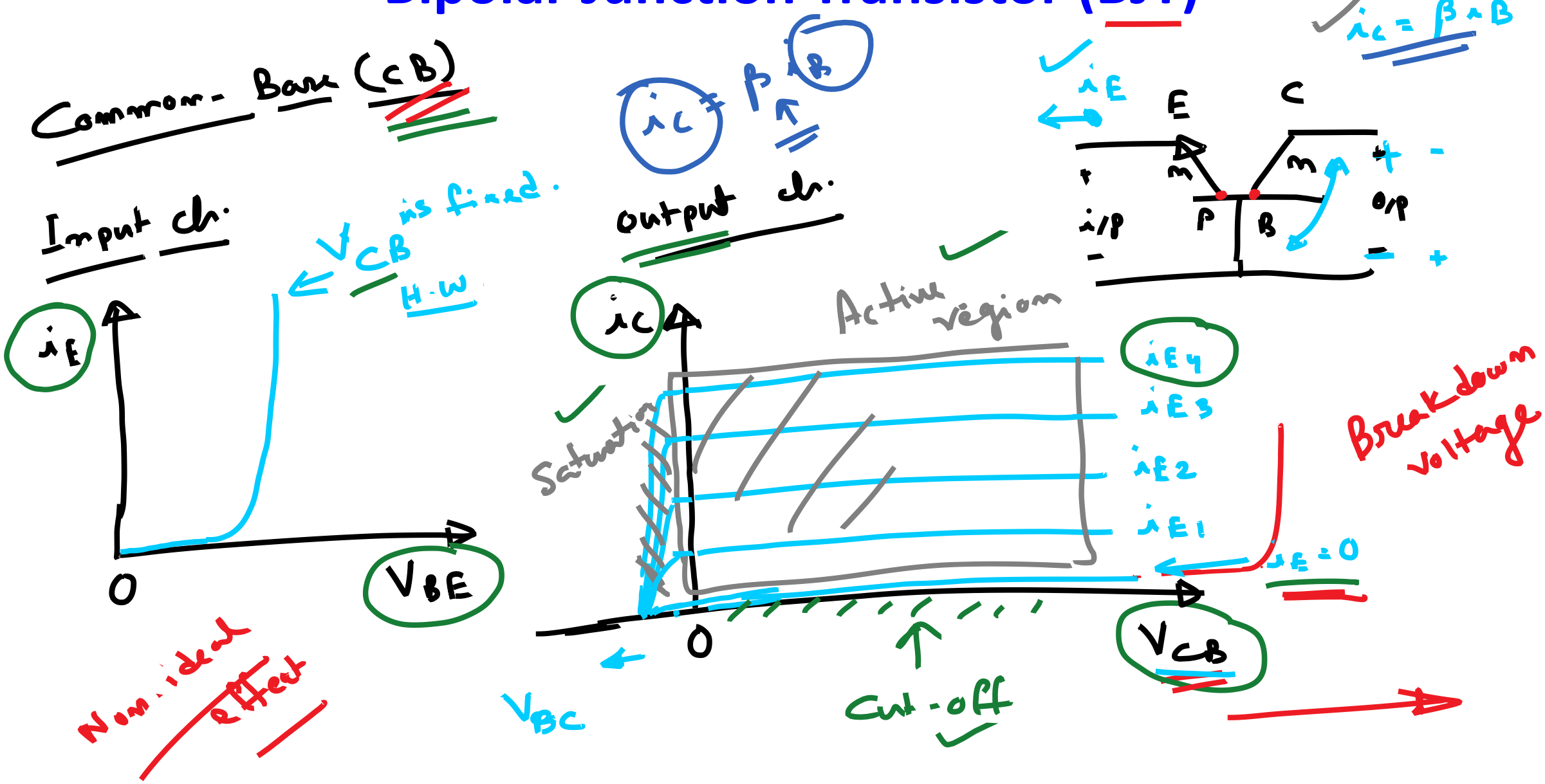
r_o

I_C → Q-current.

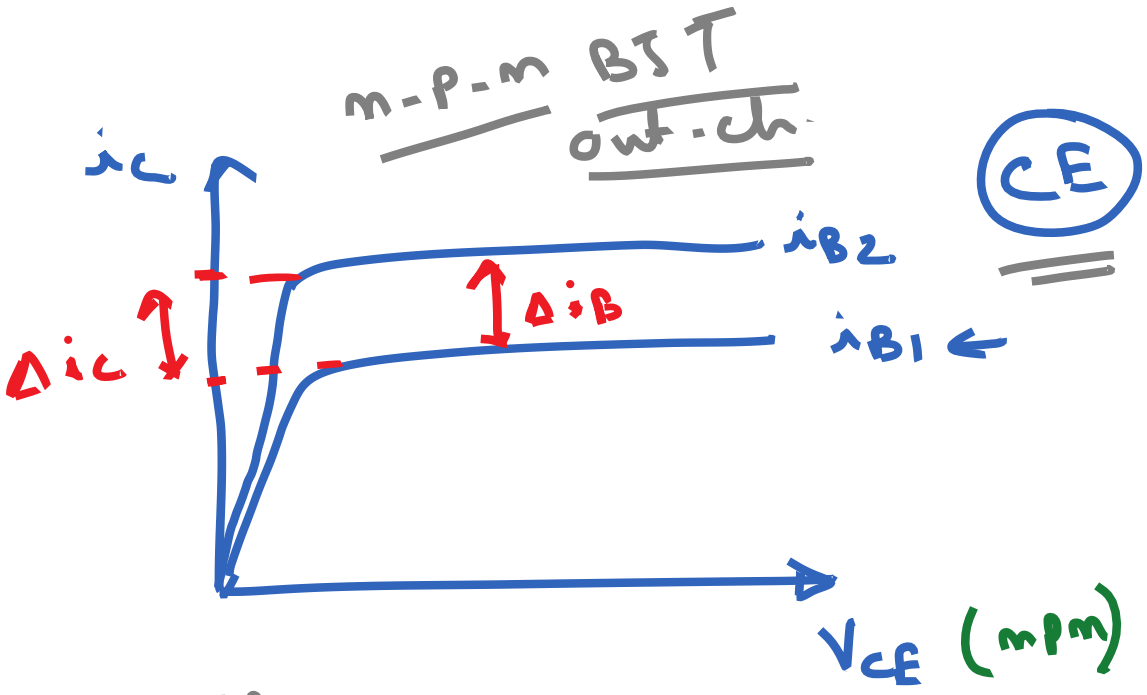


Bipolar Junction Transistor (BJT)

Common - Base (CB)

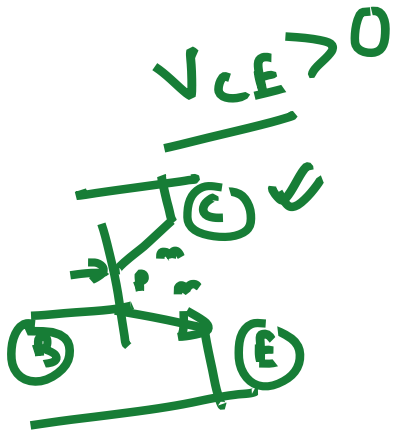


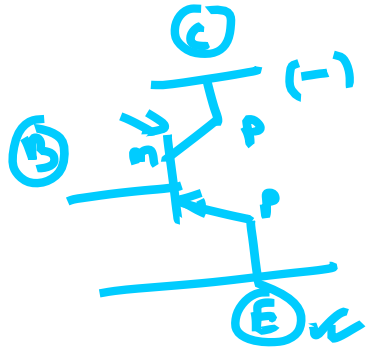
Bipolar Junction Transistor (BJT)



$$\beta_{ac} = \frac{\Delta i_C}{\Delta i_B}$$

$$\beta \approx \beta_{ac}$$





P-m-P BJT ??

'CB'-P-m-P BJT.

V_{EC} (PmP)